NAVAL HEALTH RESEARCH CENTER

PROJECTION OF PATIENT CONDITION CODE DISTRIBUTIONS BASED ON MECHANISM OF INJURY

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Executive Summary

Problem

Military doctrine is changing toward smaller forces, increased forward medical presence, and better weapons and technologies, which puts a premium on the type of casualties to be expected. Current medical planning for military operations employ computer-aided models to estimate resource requirements, conduct mission rehearsal and evaluate various courses of action. Thus far there have not been patient streams projected by the mechanism of injury causing the injuries.

Objective

The present investigation provides a method to project a patient stream based on the anticipated mix of causative agents. The patient stream distribution is based on empirical results from historical combat operations and in a format compatible with the requirements of military medical models.

Approach

Derivation of the patient stream distribution by mechanism of injury was estimated by: 1) determining the overall causative agent categories, 2) estimating an overall percentage distribution of causative agents, 3) calculating the percentage distributions of the traumatism categories for the individual causative agents, 4) determining the anatomical locations of the traumatisms caused by the causative agents and 5) identifying the patient condition codes mapped to the traumatisms.

Summary

Patient streams should be estimated based on specific wounding agents that are causing the combat injuries. This will allow medical planners to estimate supplies and resources more efficiently and accurately. Empirical hospitalization data from combat operations was extracted and the resulting injuries analyzed to estimate causative agent percentages. A projected patient stream distribution was derived for more than 300 Patient Condition codes based on a estimated percentage of six causative agents: Rockets, Shells, Landmines, Grenades, small arms and other or unknown.

PROJECTION OF PATIENT CONDITION CODE DISTRIBUTIONS BASED ON MECHANISM OF INJURY

The Medical Readiness and Strategic Plan (MRSP)1998-2004[1] requires that the military services develop a method for linking real world patient load data with modern Patient Condition (PC) codes to enable planners to forecast medical workload and resource requirements. Determination of the likely distribution of injuries and illnesses during combat operations is essential to the assessment of the needed medical resources required at the various levels of medical care. Medical planners and logisticians plan for medical contingencies based on anticipated patient streams, distributions of patient condition types, availability of evacuation assets, mix of healthcare providers, adequacy of the local infrastructure and needed medical materials by using simulation and modeling tools.

Such information is used by current medical planning tools such as the Medical Analysis Tool (MAT)[2], Joint Medical Semi-Automated Forces (JMedSAF)[3], and Etimating Supplies Program (ESP)[4] to estimate resource requirements, conduct mission rehearsal and evaluate various courses of action. These tools are dependent on accurate estimations of the anticipated patient streams, as well as information about the mechanism of injury, and the nature and location of the injuries. Without the proper assessment of the anticipated patient load, the medical support of the mission could be put at risk.

The objective of the proposed effort is the estimation of a patient stream distribution by causative agents to make refinements and better estimations of medical resources since resource requirements such as beds or health care personnel can dramatically fluctuate due to the nature of combat, potentially leading to shortfalls at critical times.[5] Appropriately, patient stream estimations are based on the expected trauma categories to estimate supplies and resources. However the agents causing the injuries should be estimated prior to the trauma categories. Such distributions will take into account the different wounding patterns caused by the agents thus enabling the medical planner to use their resources more efficiently.

METHODS

Data were extracted from medical records and data sets documenting casualty admissions of previous combat operations, and analyzed by the specific wounding agents. The process to develop a PC code distribution by causative agent involved the following steps: 1) determining the overall causative agent categories, 2) estimating an overall percentage distribution for the causative agents, 3) calculating the percentage distributions of the traumatism categories based on each causative agent, 4) determining the anatomical locations of the traumatisms caused by each causative agents and 5) identifying the patient condition codes mapped to the traumatisms.

CAUSATIVE AGENT CATEGORIES

Causative agent categories were classified into six groups: small arms, artillery/shells, rockets/bombs, grenades, landmines, and other. The small arms category was based on weapons such as pistols, assault rifles, and machine guns. The artillery and shells category was based on heavy land-based artillery weapons such as mortars, howitzers and armored vehicles and personnel carriers. The rockets and bombs category was based on aircraft-propelled artillery. The grenades category was based on all types of grenades including rocket-propelled grenades (RPG) and shrapnel injuries due to explosions excluding large fragment-producing injuries caused from bombs and artillery shells. The landmines category was based on all types of landmines and booby traps. The 'other' causative agent category was wide-ranging and included agents such as incendiary weapons, bayonets, and multiple or unspecified weapons.

OVERALL CAUSATIVE AGENT DISTRIBUTION

The next step in the process was to estimate an overall distribution of causative agents. Empirical results were examined from combat operations in World War II, Korea, Vietnam, the Falklands, Panama, Somalia and Desert Storm, as well as recent peacetime operations to determine an overall distribution for causative agents.[6, 7, 8, 9, 10] The peacekeeping data included casualty incidents of forces consisting of primarily European or U.S. troops. In addition, individual hospitalization records were analyzed from operations in Vietnam, Desert Storm and Zagreb.

Variations seen in the causative agent distribution for individual operations can be due to the affects of combat elements like tactical situation, the presence or absence of battlefield superiority, climatological affects and technical advances in weaponry. To account for the skewness apparent in the distribution of some of the causative agents, a Winsorized approach was used to compute an overall average percentage for each causative agent.

For this computation, the cells with the highest and lowest percentage values within each causative agent were omitted, and the mean average then calculated for the remaining cells. For example, the high value of 45.2% for Somalia and the low value of 18.7% for Kuwait were omitted from the mean calculation to calculate the small arms percentage. When the process was completed for each causative agent, the overall percentages were then rescaled to equal 100%.

Table 1. Causative Agent Distributions From Selected Combat Operations

	Gunfire	Artillery	Rockets	Grenades	Land mines	Other
	Small arms	Shells	Bombs	RPG	Booby traps	Mult
WWII	19.7	58.1	1.6	2.5	3.9	14.2
Korea	27.0	52.5	0.1	9.0	3.9	7.5
Vietnam	21.6	42.8	1.1	3.9	21.7	8.9
Kuwait	18.7	33.3	4.0	25.3	12.0	6.7
Falklands	36.5	58.4	----	----	5.1	----
Somalia	45.2	0.0	0.0	42.9	0.0	11.9
Panama[1]	35.8	11.9	----	25.8	0.6	25.8
Peacekeeping	28.3	27.8	4.1	9.5	21.3	9.0
Overall	28.0	37.6	1.7	14.6	7.8	10.3

[1]Jump-related incidents excluded

TRAUMATISMS BASED ON CAUSATIVE AGENTS

After the overall causative agent distribution was determined, the next step was to estimate traumatism percentages for each causative agent category. The traumatism categories were selected to correspond to International Classification of Diseases, 9th Revision (ICD-9) categories since hospitalization data is usually reported in this nomenclature. The categories included fractures, dislocations, sprains and strains, concussions, open wounds, crushing injuries, traumatic amputations and burns.

Small Arms

Wounding agent data by small arms were typically the most frequent and reliable of all the causative agent data available and was usually reported as gunfire or bullets, thus causing little confusion as to the mechanism of injury. Percentage distributions for the traumatism categories were determined for the five operations shown in Table 2. Typically, open wounds and fractures accounted for over 90% of injuries. A weighted average was used to estimate the overall averages based on N-size, recency and whether the data was reported by ICD-9 diagnoses or broader diagnoses categories.

Table 2. Percentage Distribution of Traumatisms by Small Arms

N-size	8465	24	68	15	57	
	Vietnam	Zagreb	Somalia[1]	Desert Storm	Falklands	Wt. Average
Amputations	0.5	4.5	7.4	–	–	2.7
Burns	0.1	–	2.9	–	–	0.8
Concussions	3.1	–	–	–	–	0.7
Dislocation	0.1	–	–	–	–	0.0
Fractures	17.0	16.7	27.9	20	5.3	19.2
Sprains/strains	0.2	–	–	–	–	0.0
Wounds	79.0	79.2	61.8	80	94.7	76.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

[1] Percentages based on wounds to the extremities

Landmines

Wounding agent data for landmines was obtained from the operations shown in Table 3. The percent of traumatic amputations for landmines was significantly higher then for other causative agents, and these occurred predominantly to the lower extremities. Further studies have classified antipersonnel landmine injuries into severity patterns, and as either pull-action or pressure-activated however this study does not make a distinction between severity patterns or the different types of landmines.[11] Booby traps were also classified into the landmine category. As with the small arms category, a weighted average was used to estimate the overall averages based on N-size, recency, and whether the data was reported by ICD-9 diagnoses or broader diagnoses categories.

Table 3. Percentage Distribution of Traumatisms by Landmines

N-size	8518	37	9	8	
	Vietnam	Zagreb	Desert Storm	Falklands	Wt. Average
Amputations	3.6	28.9	33.3	75.0	26.6
Burns	1.5	5.3	11.1	–	5.1
Concussions	2.7	2.6	–	–	1.6
Dislocation	0.3	–	–	–	0.1
Fractures	12.6	26.3	33.3	–	20.8
Sprains/strains	0.8	–	–	–	0.3
Wounds	78.5	36.8	22.2	25.0	45.5
	100.0	100.0	100.0	100.0	100.0

Artillery and Shells (Land Based Artillery)

The artillery and shell causative agent category was comprised of wounds caused from land-based artillery such as mortars, howitzers, tanks, armored vehicles and other ground delivered artillery. Typically these weapons result in large fragment and penetrating types of injuries and cause the greatest of casualties in most present-day operations. The data used to compute the overall traumatism percentages were obtained from operations in Vietnam, Falkland Islands, Desert Storm, and Zagreb. When comparing shell wounds to gunfire wounds, the most significant difference was that amputations and multiple injuries were much higher due to the explosion and blast effects of artillery shells. The traumatism distribution for artillery and shells and the causative agent categories to follow can be found in Table 4.

Grenades

The distributions of the injuries from grenades were primarily obtained from the Vietnam operation. An additional nineteen admissions due to grenades were obtained from Desert Storm and 34 admissions from operations in Somalia. Also included in this category were shrapnel wounds due to explosions (although there were cases where it was difficult to determine if the shrapnel wounds were caused by artillery shells or grenades).

Rockets/Bombs

The distributions of injuries due to rockets/bombs were obtained from the Vietnam and Falklands operations. Typically these weapons have been used infrequently against the troops of the U.S. and its allies.

Other

The 'other' category was obtained from the Vietnam operation and consisted of unknown, multiple or causative agents that could not be classified into the other categories. A large percentage of concussions and sprains/strains were present.

Table. 4 Estimated Percentage Distribution of Traumatisms by Causative Agents

	Gunfire	Rockets	Shells	Mines	Grenades	Other
Amputations	2.7	4.1	4.1	26.6	2.5	2.3
Burns	0.8	3.7	2.5	5.1	1.0	2.3
Concussions	0.7	1.8	1.5	1.6	1.6	8.9
Dislocation	0.0	0.5	0.0	0.1	0.1	0.2
Fractures	19.2	12.0	10.7	20.8	17.0	21.0
Sprains/strains	0.0	2.3	0.7	0.3	0.3	5.0
Wounds[1]	76.5	75.7	80.6	45.5	77.6	60.3
	100.0	100.0	100.0	100.0	100.0	100.0

[1]Wounds category includes multiple and crushing wounds

ANATOMICAL LOCATIONS OF TRAUMATISM CATEGORIES

Given the causative agent and the resulting traumatisms, the next step was to determine the distribution of the anatomical location of the injuries. Typically, anatomical location percentage distributions have been reported across all injuries without making a distinction if the injury was a result from a landmine, grenade or other causative agent. In order make the distinction of the anatomical location by injury and causative agent individual ICD-9 codes or hospitalization records were needed to make those determinations. The best overall data set that recorded anatomical location for traumatisms grouped by causative agents was obtained from the Vietnam operation. Over 39,000 hospitalization records were analyzed and grouped by causative agent, traumatism group and anatomical location. The large number of records ensured a sufficient number of cases to accurately reflect wounding patterns for most of the data cells. The drawback is that the wounding patterns evidenced in Vietnam do not reflect the impact of recent advances in weaponry and force protection. Some of this problem will be alleviated by limited data obtained from operations in Somalia, Desert Storm, and the Zagreb peacekeeping mission.

With the advancements in effective body armor, penetrating wounds to the torso have declined while wounds to the unprotected portion of the head and to the extremities remain vulnerable. An example of this is evidenced by the experience of the US Army Rangers in Somalia, who received no penetrating injuries to the chest among their WIA casualties. However when comparing injuries to the chest among fatalities or died-of-wound casualties, a reduction of 39% versus 14% was reported when compared to Vietnam.

The widespread use of body armor has prevented thoracic injuries reducing the need to perform additional diagnostic studies, serial examinations, and surgical exploration required by such casualties, thereby reducing the surgical workload. Consequently adjustments to the thoracic region will be decreased by 50% to reflect the increased effectiveness of body armor. A detailed breakdown of the anatomical locations of the traumatisms by causative agent is illustrated in Table 5.

Table 5. Estimated Percentage Distribution of Anatomical Locations By Trauma Type and Mechanism of Injury

Traumatism	Gunfire	Rockets	Shells	Mines	Grenades	Other
Amputations						
Lower	35.9	61.6	51.6	83.9	59.3	64.2
Upper	64.1	38.4	48.4	16.1	40.7	35.8
Burns						
Head/Face	16.6	21.4	44.4	64.0	33.3	45.8
Lower	16.6	7.1	11.1	2.0	0.0	6.0
Thorax	16.6	28.6	44.4	16.0	50.0	26.2
Upper	50.0	42.9	0.0	18.0	16.7	22.0
Dislocations						
Elbow	14.3	0.0	0.0	0.0	0.0	11.1
Wrist	28.6	0.0	0.0	0.0	0.0	0.0
Shoulder	42.9	100.0	100.0	88.9	0.0	83.3
Fingers	14.3	0.0	0.0	11.1	100.0	5.6
Fractures						
Face	7.0	4.0	11.9	9.4	10.0	7.9
Femur	17.9	14.0	8.5	7.8	4.4	10.6
Foot/Toe	5.2	2.0	5.8	6.9	6.7	7.6
Hand/Finger	8.2	10.0	15.0	9.8	16.7	11.4

Humerus	12.4	4.0	8.1	5.6	6.7	9.0
Knee	0.8	6.0	0.8	2.3	1.1	3.7
Jaw	0.7	2.0	2.7	3.1	2.2	3.2
Pelvis	2.5	0.0	0.8	0.7	2.2	1.3
Radius/Ulna	14.0	14.0	16.7	16.5	20.0	14.7
Ribs	4.0	2.0	1.2	1.7	1.1	2.4
Skull	2.1	12.0	6.0	4.2	7.8	5.0
Shoulder	4.1	6.0	2.1	1.5	1.1	1.8
Spine	4.0	4.0	2.5	4.7	2.2	3.8
Tibia/Fibula	17.2	20.0	18.1	25.8	17.8	17.9
Sprain/Strain						
Ankle	23.1	100.0	40.6	25.8	33.3	41.8
Back	53.8	0.0	34.4	64.5	50.0	44.3
Knee	15.4	0.0	21.9	9.7	16.7	12.7
Wrsit	7.7	0.0	3.1	0.0	0.0	1.1
Open Wounds						
Abdomen	1.9	0.9	0.8	2.4	1.7	3.6
Arm	25.3	23.4	26.1	21.9	20.5	18.5
Body	8.9	5.1	4.6	5.1	5.8	7.6
Buttock	3.7	3.7	3.6	2.9	3.7	3.1
Ear	0.3	4.3	1.5	3.3	3.9	2.3
Eye	0.3	0.9	1.1	3.0	2.9	2.2
Face/Neck	5.0	12.1	9.3	9.5	9.5	7.9
Foot/Ankle/Toe	4.5	3.3	2.7	2.1	1.9	4.4
Genital	0.4	0.9	0.6	0.4	0.7	0.5
Hand/Finger	5.2	4.2	6.3	4.3	5.3	5.8
Head	1.8	1.9	1.8	3.3	1.5	2.8
Leg	36.1	36.0	36.3	37.4	37.6	36.1
Thorax	6.6	3.3	5.5	4.5	5.0	5.3

PATIENT CONDTION CODE DISTRIBUTION

To calculate individual PC code probabilities, conditional probabilities were derived for each traumatism by anatomical location for a given causative agent. For example, a fractured femur caused by gunfire would be calculated by determining the probability of fractures to the lower extremities caused by small arms multiplied by the probability that a small arm fracture injury would be to the femur.

P (Fracture | Gunfire) = 0.192

P (Femur | Fracture from Gunfire) = 0.179

P (Fractured Femur resulting from Gunfire) = 0.208 0.179 = .034 or 3.4%*

Hence, each individual PC code percentage is computed as the product of the traumatism percentage and the anatomical location percentage given the causative agent.

Three adjustments were made to the PC Code distributions. First, there are cases when multiple PC codes correspond to a single “traumatism by location” combination. Oftentimes these multiple codes correspond to the level of severity. In these cases, the expected percentage for a given PC code is the ratio derived by the Joint Readiness Clinically Advisory Board.

The second adjustment was in the estimation of closed fractures opposed to open fractures. Based on previous study at Naval Health Research Center, eighty-seven percent of fractures our open for WIA admissions and this percentage will be applied to all causative agents.[12]

The final adjustment was estimating multiple wounds that result from the causative agents. The multiple injury percentages varied based on each causative agent. The data used to estimate these percentages was predominantly based on individual hospitalization records of Marine admissions during the Vietnam operation and supplemented with data from Desert Storm and Somalia. The final trauma categories with the fracture and multiple breakdowns are shown in Appendix A. and the distribution of all PC codes are shown in the Appendix B.

DISCUSSION

The nature of injuries on any battlefield reflects the predominant weapons used by the combatants. A review of casualty data sources in the last 50 years show 25% of landmine injuries resulting in amputations, predominantly to the lower extremities. Small arms had a large percentage of fractures to the extremities, while grenades and RPG’s were the largest producer of multiple wounds. World War II and Korean had similar percentages of causative agents. In Vietnam, mines and boobytraps were more than three times as likely to produce casualties when compared to other operations. In Somalia, there were no casualties caused by artillery shells.

Distributions of anatomical location of wounds have changed to advancements of body armor and protective gear, and vary based on the type of causative agent. Recent advances in body armor seem to have reduced mortality when comparing fatal penetrating injuries to the chest. A reduction of 39% versus 14% was reported in a study in the Journal of Trauma, although the face, neck, pelvis and groin remained vulnerable. However blunt injuries to the thoracic region still remain evident as most notably observed during Operation Enduring

Freedom where 2 out of 3 injuries to the thoracic region were blunt injuries.[13] An inclusion of blunt injuries to the thoracic region should be included to the PC code nomenclature due to the increased effectiveness in body armor.

Data on relative lethality of wounds and the distribution by causative agent demonstrate the advantage of wearing properly designed body armor. Penetrating wounds to the head remain a significant cause of mortality on the battlefield. During Vietnam, a quote from Colonel William M. Hammon stated, "If our combat troops . . . were to wear the helmet, we, believe that about 1/3 fewer significant combat casualties would need to be admitted to a neurosurgical center here in Vietnam."[14] Similarly fatalities to the head during WWII and Korea were 19.7 and 25.4 percent of among all deaths.

As Operation Iraq Freedom has ended there has been continued attacks by loyalists of Saddam Hussein's military and other forces, resulting in an increasing number of US troops being injured through small-arms fire, rocket-propelled grenades, remote-controlled mines and what the Pentagon refers to as "improvised explosive devices." The injuries resulting from these incidents will be used to adjust the traumatism distributions when the data becomes available.

CONCLUSION

Estimates of the likely distribution of patient streams are a key component in ensuring adequate programming of resources to meet the medical needs of combat operations. Military operations in the future will likely take place in urban environments making casualties more vulnerable to close quarter combat producing unique patterns of injury. Wounding patterns need to be analyzed by mechanism of injury enabling planners to anticipate the type of injuries to be expected. As computer simulation capabilities expand, it will be possible to incorporate an increasing number of factors to enhance medical forecasting accuracy for the derivation of corollary projections of the staffing demands, requisite equipment, and needed medical supplies. Use of empirical data from previous operations provides a baseline for projecting casualty incidence for future scenarios. Percentage distributions were calculated according to causative agent, traumatisms, and anatomical locations, and the results mapped to PC codes. Combining the expected PC code distributions with the projected overall WIA and DNBI incidence rates will allow planners to forecast a representative patient stream given the likely mix of wounding agents and more accurately project medical resource requirements.

References

[1] Medical Readiness Strategic Plan (MRSP) 1998 – 2004, Department of Defense, 5136.1-P August 1998.

[2] Booz Allen & Hamilton Incorporated. Medical Analysis Tool Version 2.0.1.1 Technical Reference Manual, 2000.

[3] http://www.spawar.navy.mil/sti/publications/pubs/td/3117/165.pdf

[4] Tropeano, A. Estimating Supplies Program, 2000. San Diego, CA.: Naval Health Research Center No. 00-4D.

[5] Zouris, JM, Blood CG. Medical Resource Planning for Combat Operations: Utilizing Percentile Estimates as an Alternative to the Mean. Journal of Medical Systems, Vol. 24, No. 6, 379-387, 2000.

[6] Reister FA. Medical statistics in World War II, Office of The Surgeon General Department of the Army, Washington, D.C., 1975.

[7] Reister FA. Battle Casualties and Medical Statistics U.S. Army Experience in the Korean War, Office of The Surgeon General Department of the Army, 1973.

[8] Falklands, Operation Corporate - Falkland Islands 1982, Day by day details of personnel Killed in Action, Sick & Wounded in Action (4 volumes), NHRC San Diego Casualty Study.

[9] Mabry, RL, Holcomb JB, Baker AM, Cloonan CC, Uhorchak JM, Perkins DE, Canfield AJ, Hagmann JH. United States Army Rangers in Somalia: An Analysis of Combat Casualties on an Urban Battlefield, The Journal of Trauma, Vol. 49, No. 3, 2000.

[10] Blood CG, Zhang J, Walker GJ. Implications for Modeling Casualty Sustainment during Peacekeeping Operations, Military Medicine, 167, 2002.

[11] Soldo S, Puntaric D, Petrovicki Z, Prgomet D. Injuries Caused by Antipersonnel Mines in Croatian Army Solodiers on the East Slavnia Front during the 1991-1992 War in Croatia, Military Medicine, 164, 2:141, 1999.

[12] Walker GJ, Zouris JM, Blood CG. Projection of Patient Condition Code Distributions During Ground Operations. San Diego, CA.: Naval Health Research Center Report No. 99-17, 1999.

[13] ATTAC Conference 2002. 274th FST(ABN) Operation Enduring Freedom Stronghold Freedom/Bagram 18OCT01 – 9 MAY02.

[14] Ned S. Medical Support of the U.S. Army in Vietnam 1965-1970, Department of the Army, Washington, D.C., 1991

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14. ABSTRACT (maximum 200 words)

The Medical Readiness and Strategic Plan 1998-2004 requires that the military services develop a method for linking real-world patient load data with modern patient condition codes to enable planners to forecast medical workload and resource requirements. Medical planners and logisticians utilize modeling and simulation tools to plan for medical contingencies based on anticipated patient streams, availability of evacuation assets, mix of healthcare providers, adequacy of the local infrastructure and the volume of needed medical materials. Determination of the likely distribution of injuries and illnesses during combat operations is a particularly critical component to the assessment of the needed medical resources required at the various levels of medical care.

The objective of the proposed effort is to more accurately project patient streams contingent on the likely weapons that US forces will encounter in future combat operations. By incorporating causative agents and their prospective impacts, a refinement of current patient stream projections is possible. Presently, patient stream estimations are based on the expected trauma categories derived from casualty distributions observed in previous operations. It is the goal of this effort that the likely distribution of expected causative agents be derived prior to estimating the expected trauma categories.

15. SUBJECT TERMS
casualty projections, wounded in action, simulation techniques, medical planning, patient condition codes, causative agents, mechanism of injury

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